Pre-Aerosols, Clouds and Ecosystems - Ocean Ecology Spectrometer (PACE-OES) ~ Concept Presentation~

Parametric Cost Modeling

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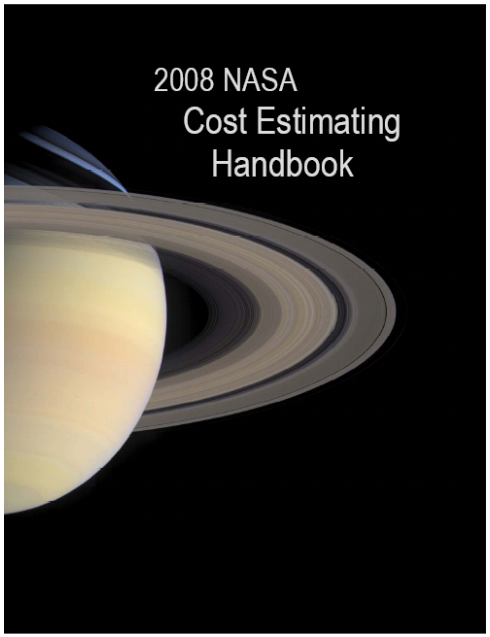
NASA Cost Estimating Overview

NASA Cost Estimating Handbook 2008

- Defines three cost estimating Methodologies
  - **Parametric**: based on key engineering data and Cost Estimating Relationships (CERs)
  - **Analogy**: comparison and extrapolation to like items or efforts
  - Engineering Build-Up (i.e., "**grass-roots**"): Labor and Material estimates based on experience and "professional judgment"
- Defines two cost estimating Processes
  - **Advocacy Cost Estimates (ACE)**
    - Cost Estimators are members of program/project team
  - **Independent Cost Estimates (ICE)**
    - Cost Estimators are from an organization separate from project
- Encourages parametric modeling and analogy estimates during pre-Phase A and Phase A studies

http://www.nasa.gov/offices/pae/organization/cost_analysis_division.html

http://ceh.nasa.gov



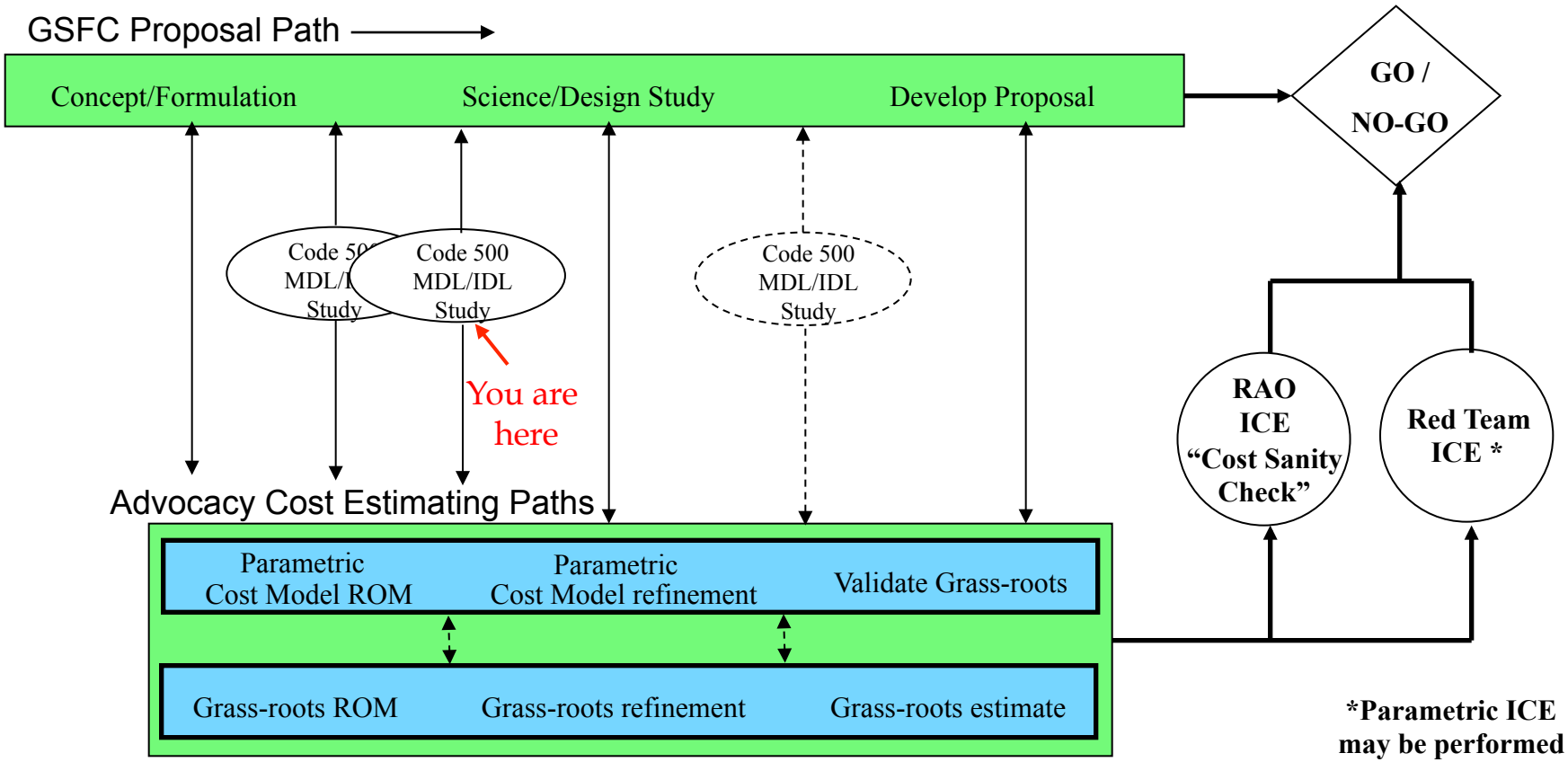
Proposal cost estimates evaluated at NASA Langley Research Center during Technical, Management, and Cost (TMCO) review

- Parametric models used to validate proposal cost estimate
- Assumed criteria for validation of Step 1 proposal (based on feedback): proposal estimate and TMCO consensus estimate within 20%

Current GSFC Proposal Cost Estimating "Best Practices"

- **Advocacy Cost Estimating**
  - **MDL, Proposal Teams**
    - Grassroots estimate based on Work Breakdown Structure (WBS)
    - Parametric modeling used for Grassroots validation
  - **IDL**
    - Parametric modeling used to generate a stand-alone cost estimate
    - No Grassroots (WBS) cost estimate to validate
- **Independent "Assessment" (provided by RAO)**
  - Internal cost estimating tools and historical databases
  - Provides critical "Sanity Check"
- **Evolving "Best Practices"**
  - GSFC Chief Financial Officer (CFO)
  - NASA Cost Analysis Steering Group
  - NASA Cost Estimating Handbook

Proposal Cost Estimating Process



Cost estimating is an on-going iterative process

Parametric Cost Estimating Tools

- **NASA Cost Estimating Handbook 2008 describes two commercial tools**
  - **PRICE: Parametric Review of Information for Costing and Evaluation**
    - Separate modules for Hardware, Software, Integrated Circuits, and Life Cycle
    - PRICE H (Hardware) approaches cost estimates by parametrically defining:
      - Hardware to be built
      - Development and manufacturing environments
      - Operational environment
      - Schedule
    - PRICE H model is built from key engineering data (e.g., MEL: Master Equipment List)
    - Tool Heritage: Developed by RCA in the 1960's for the U.S. NAVY, Air force & NASA; Commercialized by PRICE Systems, L.L.C.
    - NASA-wide site license for PRICE H managed by Langley Research Center
      (GSFC Contact: Dedra Billings, Code 305.0, e-mail: Dedra.S.Billings@nasa.gov)
    - PRICE H use at GSFC:
      - Mission Design Lab (MDL/IMDC), 10+ years experience and 150+ S/C Bus models
      - Instrument Design Lab (IDL/ISAL), 8+ years experience and 120+ Instrument models
      - Code 600, 10+ years experience, 100+ S/C Bus and 100+ Instrument models
  - **SEER: System Evaluation & Estimation of Resources**
    - Separate modules for Hardware, Software, Integrated Circuits, Manufacturability and Life Cycle
    - NASA-wide site license for SEER managed by Langley Research Center
    - Application-specific use of SEER-H at GSFC (e.g., detectors, cryocoolers, etc.)

PRICE H: Key Input Parameters

- **Global Parameters:**
  - Labor Rates (set as appropriate)
    - GSFC Bid Rates (used for in-house build of spacecraft/instrument)
    - This Study → GSFC Typical Contractor Rates
      - Used for GSFC vendor provided hardware
      - Used when actual rates are not available
      - 10% G&A, 14% Fee
    - PRICE H Industry Labor Rates (default labor rates provided by Price Systems, Inc.)
      - ?% G&A, ?% Fee
  - Inflation (NASA escalation rates)
  - Engineering Environment (Defined for NASA by PRICE Systems, Inc. calibration study)
    - Emphasizes: System Engineering, Project Management, Automated design capabilities
- **Individual Cost Component Parameters:**
  - Complexity Factors (Table driven, defined by Price Systems from industry experience)
  - Modification Level/Remaining Design Factor (Heritage)
  - Quantity and Design Repeat (Learning Curve)
  - Composition (Structure, Electronic, Purchased, Cost Pass-through)
  - Mass
  - Operating Platform (Unmanned Space – High Reliability)

IDL Parametric Cost Modeling

PACE-OES Parametric Inputs:

- IDL Discipline Presentations
- Master Equipment List (MEL)

Key Assumptions:

- Class S Electronics
- All Parts of Instrument (s) built by Contractors (used GSFC Contractor Bid Rates)
- PRICE-H Model with Constant Yr$12
- No existing Manufacturing Process and Assembly Line
- PRICE-H Estimate for (1) Flight Unit, (1) ETU, and (1) partially EDU
- Schedule used: Project Start 7/2013, CDR 5/2015, and Production End 11/2016
- IDL Grassroots Cost Estimates for XXXXX Detectors (CLOUDS SWIR)
- SEER-H SpyGlass Estimates for Red & Blue CCD FPA, and OCEANS SWIR Detectors
- IDL Grassroots Estimate for FSW (in FY$12)
- IDL Grassroots Estimate for Development for FPGAs & Specific Algorithms (in FY$12)

Output Products:

- Powerpoint presentation
- PRICE H model results exported to Excel Spreadsheet

PRICE Cost Summary

(GSFC Contractor bid rates, Constant '12 Dollars, Qty. 1 Flight & 1 EDU)

Integrated Design Capability / Instrument Design Laboratory

Basic Estimate (Metric)

Cost Summary | LM Totals | LM Production | LM Development

PACE-OES Instrument Assembly- All Electronics Class-S
Wed September 14 2011 1:34 PM (PRICE Estimating Suite 2010F)
Assembly Cost — Costs in ($1000 Constant 2012)

Program Cost	Development	Production	Total Cost
Engineering			
Draft	9529.222	1408.147	10937.369
Design	42404.977	8382.500	50787.477
System	13499.906	-	13499.906
Proj. Mgmt.	13589.595	10021.726	23611.321
Data	192.871	159.708	352.580
SubTotal(ENG)	79216.572	19972.081	99188.653
Des Int Cost	[910.888]		
Manufacturing			
Production	-	27396.650	27396.650
Prototype	8726.301	-	8726.301
Tool Test Eq.	1160.328	920.459	2080.787
Purchased	1.324	610.337	611.661
SubTotal(MFG)	9887.952	28927.446	38815.398
G & A / CoM	8638.179	4432.591	13070.770
Fee / Profit	13683.978	7466.497	21150.475
Total Cost	111426.681	60798.615	172225.296
System Total	111426.681	60798.615	172225.296
Schedule Start	Jul 13 [17]	May 15 [18]	
First Item	Nov 14 [1]	Oct 16 [1]	
Finish	Dec 14 [18]	Nov 16 [19]	

Assy Weight	165.99	Assy WS	144.75
Assy Series MTBF Hrs	644.136	Unit Assy Cost	34661.47
Assy Quantity	1	Avg Assy Cost	60798.61

Engineering

Project Management

Manufacturing

Schedule

Mass

Cost Element (Summary Report Available for each cost element)

Constant Year Dollars ($12)

Production

Development

Instrument Development and Production Cost Estimate ~$ 172.2M

PACE-OES_ParamEst_091411.xls

Summary Cost Estimate (GSFC Contractor bid rates, '12 Dollars)

Integrated Design Capability / Instrument Design Laboratory

PRICE-H Instrument Payload Estimate	$212,760,704
The Following are NOT PRICE-H estimates but are derived from PRICE-H estimates. These are included for completeness and are considered ROM 'Grass-roots' estimates. Consult the Grass-roots estimating organization for a more accurate estimate.	
Flight Software (IDL Grassroots Cost Estimate in FY$12)	$1,470,956
FPGA Development (3 Unique FPGAs @ $446.4K ea & 4 Unique Algorithms @ $223.2K ea identified)	$2,232,000
Ground Support Equipment (GSE) (5% of Instrument Cost Estimate)	$10,638,035
Environmental Testing (5% of Instrument Cost Estimate)	$10,638,035
Flight Spares (10% of Instrument Cost Estimate)	$21,276,070
Engineering Test Unit (ETU) (10% of Instrument Cost Estimate)	Included Above
Instrument Subtotal	$259,015,800
Institutional Charges (Basis of Estimate: 16.0% GSFC CM&O) (For GSFC, Contact Code 153 to verify applicability to your project)	N/A
Instrument Total	$259,015,800

Estimate in R$Y for 60/40 Cost Fraction options

Using JSC Typical Values : Cost Fraction = 0.6 ; 60% of the cumulative cost has been expended when 50% of cumulative time has been reached

Year	Inflation Index	Annual Cost (Yr$12)	Annual Cost (Real Yr$)
2013	0.03	$10,556,578	$11,457,127
2014	0.029	$73,773,216	$82,388,510
2015	0.028	$98,581,777	$113,176,873
2016	0.028	$64,211,626	$75,782,308
2017	0.029	$11,892,603	$14,442,635
Total Cost Estimate		**$259,015,800**	**$297,247,452**

ORCA_2009 - Recosted
(w/ new schedule & GSFC Contractor bid rates, '12 Dollars)

PRICE-H Instrument Payload Estimate	**$204,788,007**
The Following are NOT PRICE-H estimates but are derived from PRICE-H estimates. These are included for completeness and are considered ROM 'Grass-roots' estimates. Consult the Grass-roots estimating organization for a more accurate estimate.	
Flight Software (IDL Grassroots Cost Estimate in FY$12)	**$1,470,956**
FPGA Development (3 Unique FPGAs @ $446.4K ea & 4 Unique Algorithms @ $223.2K ea identified)	**$2,232,000**
Ground Support Equipment (GSE) (5% of Instrument Cost Estimate)	**$10,239,400**
Environmental Testing (5% of Instrument Cost Estimate)	**$10,239,400**
Flight Spares (10% of Instrument Cost Estimate)	**$20,478,801**
Engineering Test Unit (ETU) (10% of Instrument Cost Estimate)	**Included Above**
Instrument Subtotal	**$249,448,564**
Institutional Charges (Basis of Estimate: 16.0% GSFC CM&O) (For GSFC, Contact Code 153 to verify applicability to your project)	**N/A**
Instrument Total	**$249,448,564**

ORCA-2009 in R$Y : 60/40 Cost Fraction options

Using JSC Typical Values : Cost Fraction = 0.6 ; 60% of the cumulative cost has been expended when 50% of cumulative time has been reached

Year	Inflation Index	Annual Cost (Yr$10)	Annual Cost (Real Yr$)
2013	0.03	$10,166,651	$11,033,936
2014	0.029	$71,048,263	$79,345,335
2015	0.028	$94,940,474	$108,996,472
2016	0.028	$61,839,849	$72,983,146
2017	0.029	$11,453,327	$13,909,169
Total Cost Estimate		**$249,448,564**	**$286,268,058**